International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 5, Issue 4, Aug 2015, 49-52

TRANS STELLAR
• Journal Publications • Research Consultancy

A STUDY ON PHYSICAL PROPERTIES OF COTTON SEEDS FOR DEVELOPING A HIGH DENSITY COTTON PLANTER

G. VASUKI[1] & A. TAJUDDIN[2]

[1]Research, Scholar, Agricultural Machinery Research Centre, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

[2]Professor, Agricultural Machinery Research Centre, Agricultural Engineering college and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

ABSTRACT

Design of metering mechanism and other components of a prototype inclined plate planter has been done from the engineering properties of cotton seeds viz., size, sphericity, thousand seed mass, bulk density, angle of repose, coefficient of friction and true density. Five varieties of cotton seeds were used in this study namely Anjali, Suraj, KC_3, NH615 and PKV081 which are suitable for high density planting system of cotton. Cell size of the seed metering disc was designed with reference to maximum breadth, width and length of seeds. Sphericity ranged from 0.636± 0.016 to 0.687 ± 0.02 and thousand seed mass from 61.60± 0.089 to 93.6 ± 0.120 g. Capacity of seed hopper depends on the bulk density of seeds. The bulk density varied from 613 to 648 kg m^{-3}. The angle of repose varied from 19.2 to 26.3 deg. To ensure free flow of cotton seeds, slope of the seed hopper was taken as 30^0 which is higher than the average angle of repose of cotton seeds. The static co efficient of friction of cotton seed was determined on four materials namely, stainless steel (0.28 to 0.35), mild steel (0.38 to 0.43), ply wood (0.40 to 0.45) and rubber (0.43 to 0.46).True density varied from 989 to 1000 kg m^{-3}.

KEYWORDS: Bulk Density, Cell Size, Co Efficient of Friction, Cotton Seeds

INTRODUCTION

Cotton is an important commercial crop grown over 111 countries throughout the world. India having 11.61Mha area under cotton cultivation stands first among the cotton growing countries followed by USA and China. India stands fourth in total seed cotton production in the world. To design the seed metering device for planting cotton, it is necessary to determine the physical properties of delinted cotton seeds as a function of moisture content. The movement of seeds through a planter is dependent on size, shape, sphericity, true density and angle of repose of seeds. Therefore attempts were made to find the optimum design parameters of a planter by determining the relevant physical properties of cotton seeds for 5 varieties.

Ozarslan (2002) measured physical properties of delinted and bare cotton seeds. The average length, width and thickness of cotton seeds ranged from 9.02 to 9.19, 4.70 to 4.86 and 4.25 to 4.45 mm as the moisture content increased from 8.33 to 13.78 per cent (d.b.) respectively. In the same moisture range, studies on rewetted cotton seed showed that the sphericity increased from 0.626 to 0.635, seed volume from 95.4 to 109.6 mm^3, thousand seed mass from 104.06 to 109.64 g and projected area from 35.89 to 40.14 mm^2.The bulk density decreased from 642 to 610 kg m^{-3} and true density from

1091 to 1000 kgm^{-3}. Jayan and Kumar (2004) evaluated physical properties of maize, red gram and cotton seeds as design parameters namely, length, breadth, surface area, roundness, equivalent diameter, sphericity, seed weight, true density, angle of repose and coefficient of restitution. Results revealed that maize, red gram and cotton seeds were 10.70±0.08, 7.35±0.06 and 9.10±0.09 mm long and 8.70±0.03, 6.35±0.07, 5.60±0.05 mm wide respectively. Accordingly, the seed metering device was fabricated with diameters of 11, 8, and 10 mm for maize, red gram, and cotton respectively. This is expected to meter 2 to 3 seeds when the cell hole overlaps with the hopper hole. Sphericity affects the seed flow through the various components of the planter. The sphericity of maize, red gram and cotton seeds in the natural rest position were 0.621 ± 0.065, 0.750 ± 0.016, 0.550 ± 0.016 respectively.

MATERIALS AND METHODS

Size, generally refers to the characteristic of an object which determines space requirement within the limit and is described in terms of length, width and thickness. To determine the average size of the seed, the three linear dimensions namely, length (L), width (W) and thickness (T) were measured using a vernier caliper having an accuracy of 0.01 mm for randomly selected 100 seeds (Ozarslan, 2002). One thousand seed mass was determined by measuring the weight of thousand cotton seeds in a electronic balance having an accuracy of 0.001 g. The sphericity of seed (ϕ) was calculated by using the following relationship (Mohsenin, 1970) from the measured length (L), width(W) and thickness(T) of the seeds.

$$\varphi = \frac{\langle \mathrm{LWT} \rangle^{1/3}}{\mathrm{L}}$$

Where

L= Length of seed, mm

W= Width of seed, mm and

T= Thickness of seed, mm.

As the seeds flow due to gravity, the angle of repose influences the design of inclination of seed hopper. The angle of repose was measured using a rectangular box filled with delinted cotton seeds. The filled box was kept horizontal. The seeds were then allowed to fall freely by gravity on a horizontal circular disc kept below the box. The seeds formed a heap on the disc. The radius of the base of the heap and height of the heap were measured and angle of repose was calculated using the following expression.

$$\omega = \tan^{-1}\left(h/r\right)$$

Where

ω = Angle of repose, deg

h = Height of heap, m

r = Radius of heap, m

This procedure was replicated thrice and the mean value was recorded for the selected 5 varieties of cotton separately. The known weight of cotton seeds were immersed in toluene in a container. The mass of displaced toulene was

measured, then the true density was calculated from weight of seeds and volume of toluene.

Bulk density influences the design of volume of seed hopper and is affected by the moisture content and degree of packing. The bulk density of selected verities of cotton (Suraj, Anjali, KC-3, PKV-081, NH-615) seeds were computed by standard method. A cubical container (115 mm × 115 mm × 115 mm) was filled with cotton seeds and the weights of cotton seeds were measured with 5 replications. The bulk density was determined by the following formula and used for computation of volume of seed hopper (Waziri and Mittal, 1983).

$$\text{Bulk density, (kg m}^{-3}) = \frac{\text{weight of cotton seed, kg}}{\text{volume of container, m}^{3}}$$

The experimental apparatus consist of a tube container filled with known quantity of cotton seeds and the tube was connected by a string running over a frictionless pulley to a loading pan for the determination of co efficient of static friction. Weights were added to the pan until the tube began to slide. The weight of the cotton seeds and the added weights comprise the normal force N and friction force F, respectively. The coefficient of static friction, μ was calculated as the ratio

$$\mu = \frac{F}{N}$$

The experiment was carried out using test surfaces of, ply wood, stainless steel, mild steel and rubber with five replications.

RESULTS AND DISCUSSIONS

Length, width, thickness, thousand seed weight, sphericity of cotton seeds of Anjali, Suraj, KC3, NH615, PKV081 varieties are shown in Table 1.

When the seed metering disc rotates inside the seed hopper, each seed may position itself with respect to length or width. The configuration of the cell should accommodate the seed in any position without causing external injury. From the measured values, the maximum value of length was selected for the fabrication of seed metering disc with a thickness of 5 mm.

Movement of spherical seed is usually higher under gravity than non spherical seeds. Sphericity of Anjali, Suraj, KC3, NH615, PKV 081 cotton seeds in natural rest position were 0.655 ± 0.01 0.636± 0.016, 0.687 ± 0.02, 0.672± 0.054 and 0.652± 0.073 respectively. Since the lower sphericity value of cotton was taken into consideration for designing the slope of the seed transfer unit (seed tube).

The mean angle of repose of Anjali, Suraj, KC3, NH615, PKV 081 varieties were 21.3, 21.8, 19.2, 24.2 and 26.3^{o}respectively. To ensure the free flow of seeds in a hopper, the slope of the seed hopper should be higher than the angle of repose of seeds. Hence the slope of the seed hopper was fixed at 30^{0}. Seeds that fell on the stainless steel experienced minimum coefficient of friction (Table 2). Because of high cost of stainless steel, the next one mild steel was used for the fabrication of seed hopper.

CONCLUSIONS

The configuration of the cell of seed metering disc was fixed as 8.5 mm from the maximum value of length of seeds with a thickness of 5 mm. To ensure free flow of seed from the hopper to the seed metering disc, the slope of the seed hopper was kept at 30^0 which is higher than the angle of repose of cotton seeds.

ACKNOWLEDGEMENTS

The guidance provided by the Dr.K.Kathirvel, professor, Agricultural Engineering College and Research Institute (AEC&RI), Kumulur, Trichy and Dr.K.Sankaranarayanan Principle Scientist, Central Institute of Cotton Research, Coimbatore for carrying out this study are acknowledged.

REFERENCES

1. Jayan, P.R. & Kumar, V.J. F. (2004). Planter design in relation to the physical properties of seeds. *Journal of Tropical Agriculture*, 42 (1-2), 69–71
2. Waziri, A.N. & Mittal, J.P. 1983. Design related physical properties of selected agricultural products. *Agri. Mechanization in Asia, Africa and Latin America*, 14, 59-62
3. Ogut, H. 1998. Some physical properties of white lupin. *Journal of Agricultural Engineering Research*, 69(3), 273–277.
4. Mohsenin, N. N. 1970. Physical Properties of Plant and Animal Materials. New York: Gordon and Breach Science Publishers
5. Ozarslan, C. 2002. Physical Properties of Cotton Seed. *Biosystems Engineering*, 83(2), 169–174

APPENDICES

Table 1: Size, Sphericity, Thousand Seed Weight, Bulk Density and True Density of Cotton Seeds of Selected Varieties at 95 % Confidence Limit

Parameters	Anjali	Suraj	KC3	NH615	PKV081
Length, mm	8.21 ± 0.081	9.10 ± 0.100	7.21 ± 0.09	7.51 ±0.03	8.26 ± 0.110
Width, mm	4.55 ± 0.041	4.96 ± 0.048	4.40 ± 0.093	4.33 ±0.061	4.637± 0.071
Thickness, mm	4.17 ± 0.062	4.29 ± 0.086	3.83 ± 0.078	3.95 ± 0.042	4.07 ± 0.034
Thousand seed weight, g	73.63± 0.140	93.6 ± 0.120	61.60± 0.089	74.0 ± 0.150	88.40± 0.078
Sphericity	0.655 ± 0.01	0.636± 0.016	0.687 ± 0.02	0.672± 0.054	0.652± 0.073
True density, kg m^{-3}	1151.43±0.01	1251.43±0.03	1001.43±0.05	1146.43±0.01	1341.43±0.06
Bulk density, kg m^{-3}	635	620	648	613	625

(95% confidence limit = mean ±1.645 SD)

Table 2: Coefficient of Friction of Cotton Seeds

Materials	Anjali	Suraj	KC3	NH615	PKV081
Stainless steel	0.23	0.32	0.28	0.35	0.26
Mild steel	0.41	0.38	0.40	0.43	0.39
Ply wood	0.45	0.41	0.45	0.42	0.40
Rubber	0.44	0.43	0.42	0.45	0.46